National Transportation Safety Board

Fatigue Factors in Accident Investigations: Using Science to Enhance Safety

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Board Member

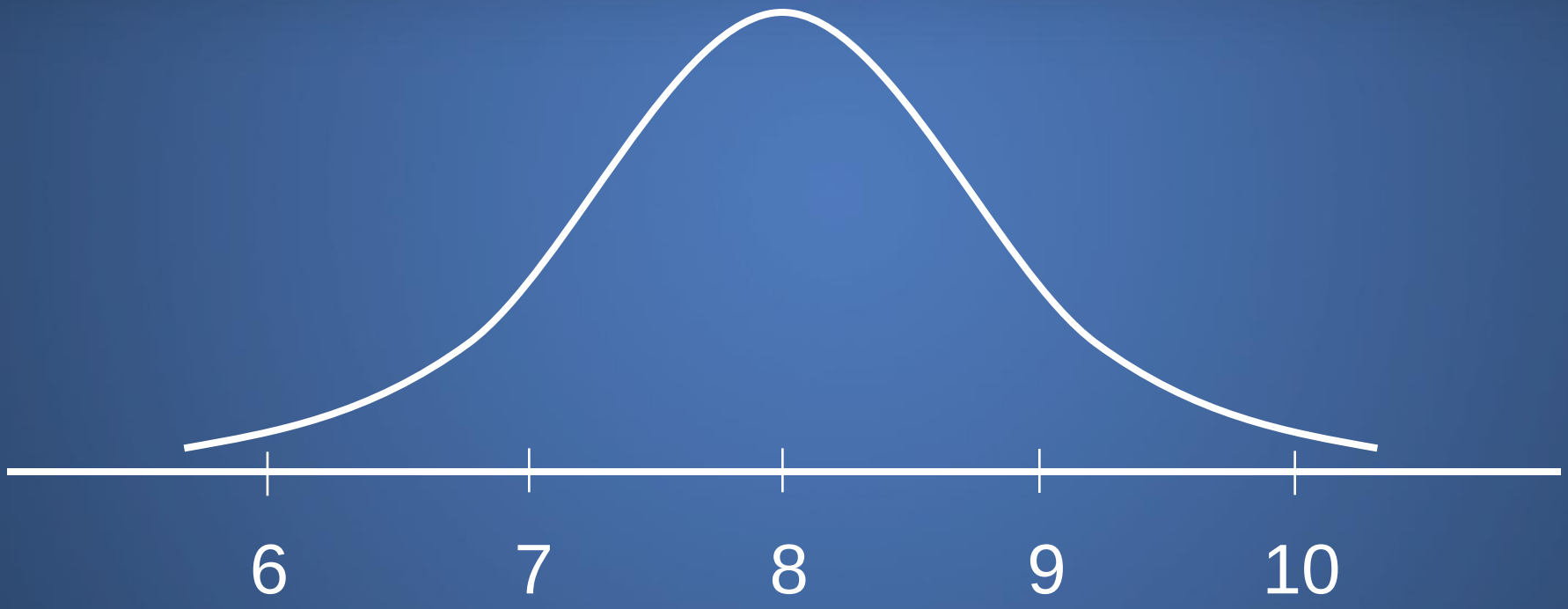
Transportation Safety Board of Canada
May 16, 2013

1) determining the probable cause of transportation accidents

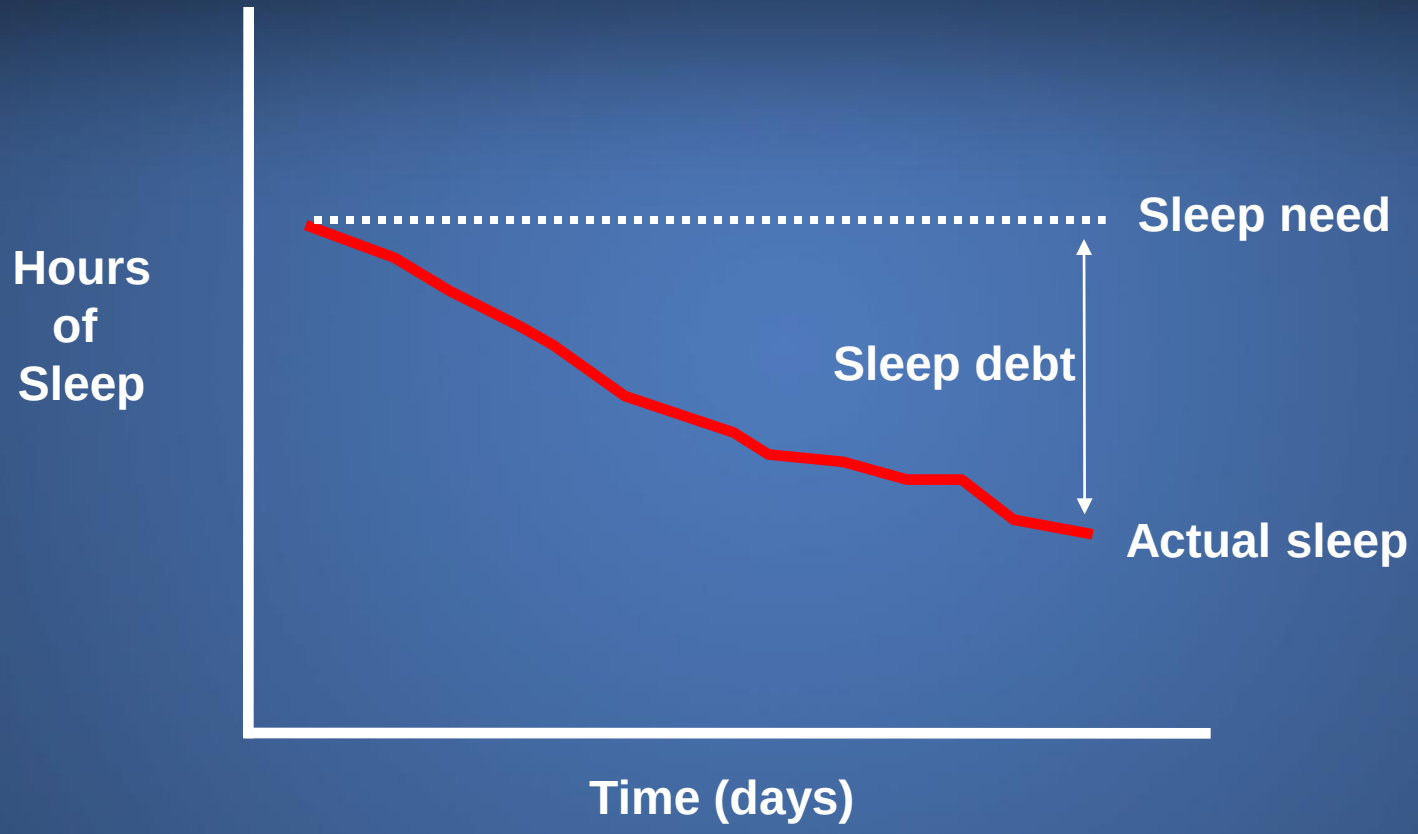
2) making recommendations to prevent their recurrence

The Science

Sleep Requirement



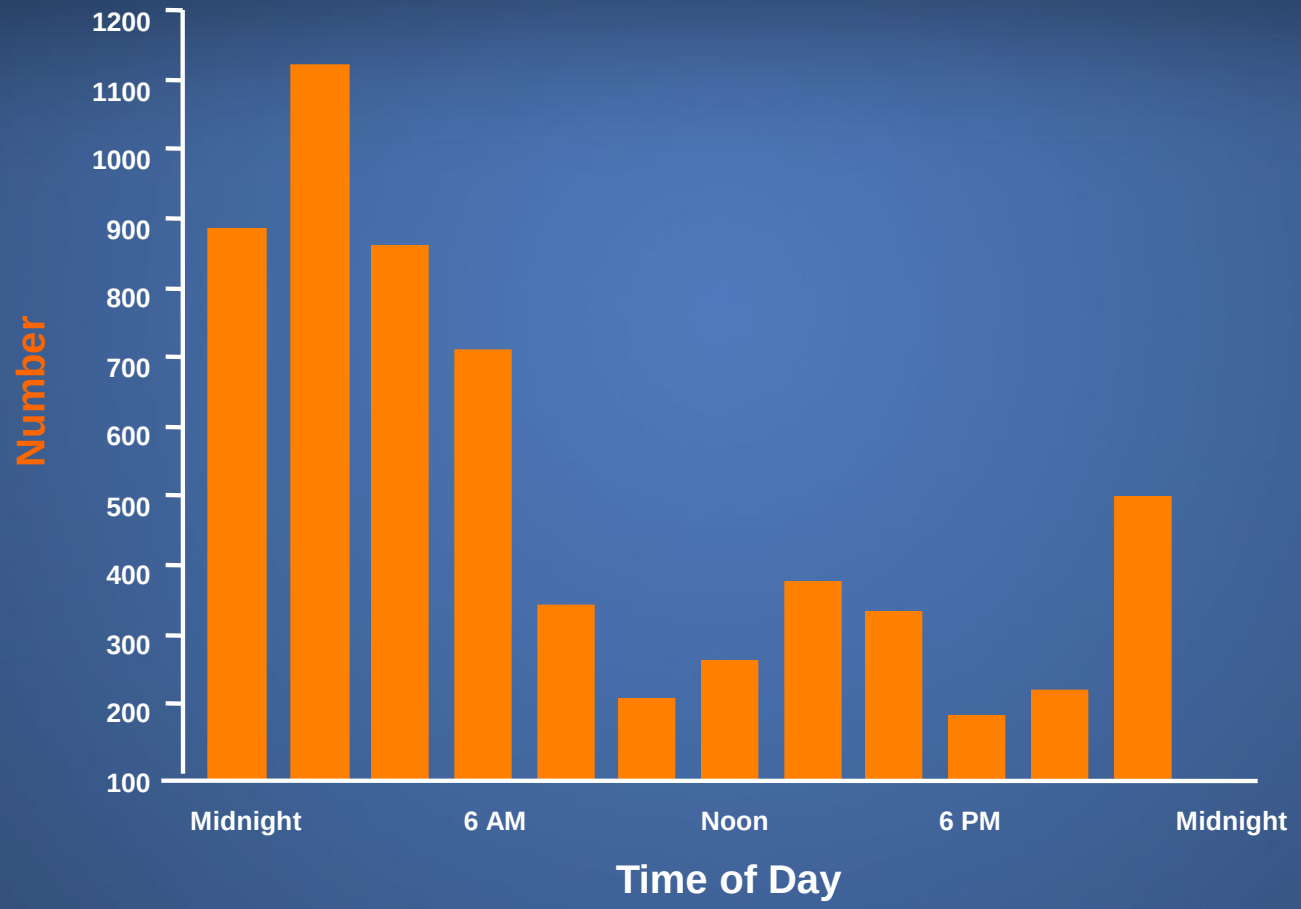
Cumulative Sleep Debt



Sleep Need – Actual Sleep = Sleep Debt

Sleep debt grows cumulatively over time

Fatigue-Related Car Crashes



M.M. Mitler, et al., Sleep, 1988

International Data
N-6052

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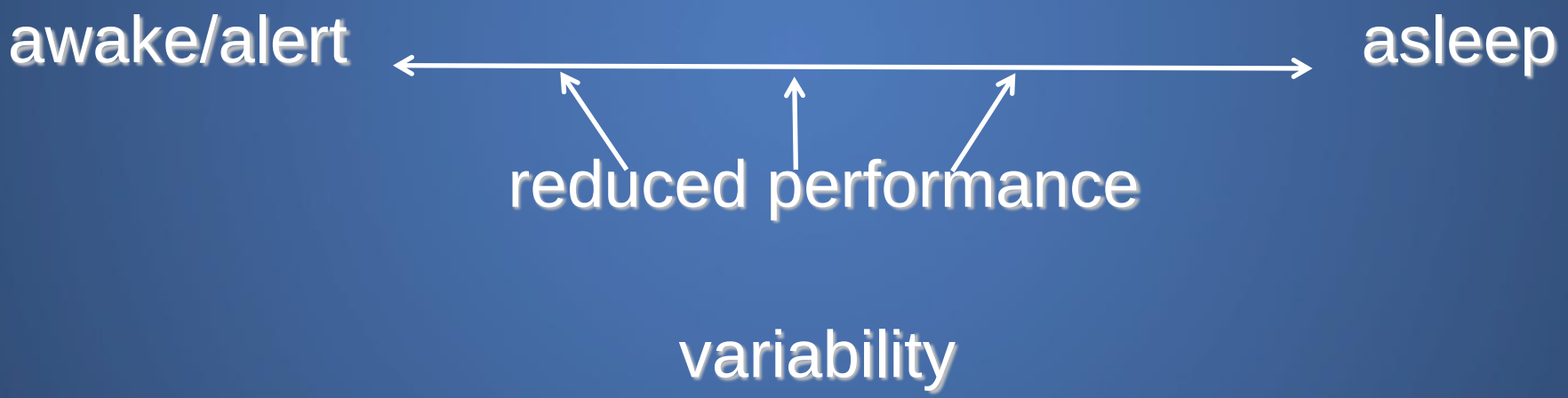
Fatigue Risks

Fatigue can degrade every aspect of human capability.

Fatigue Risks



Fatigue Risks

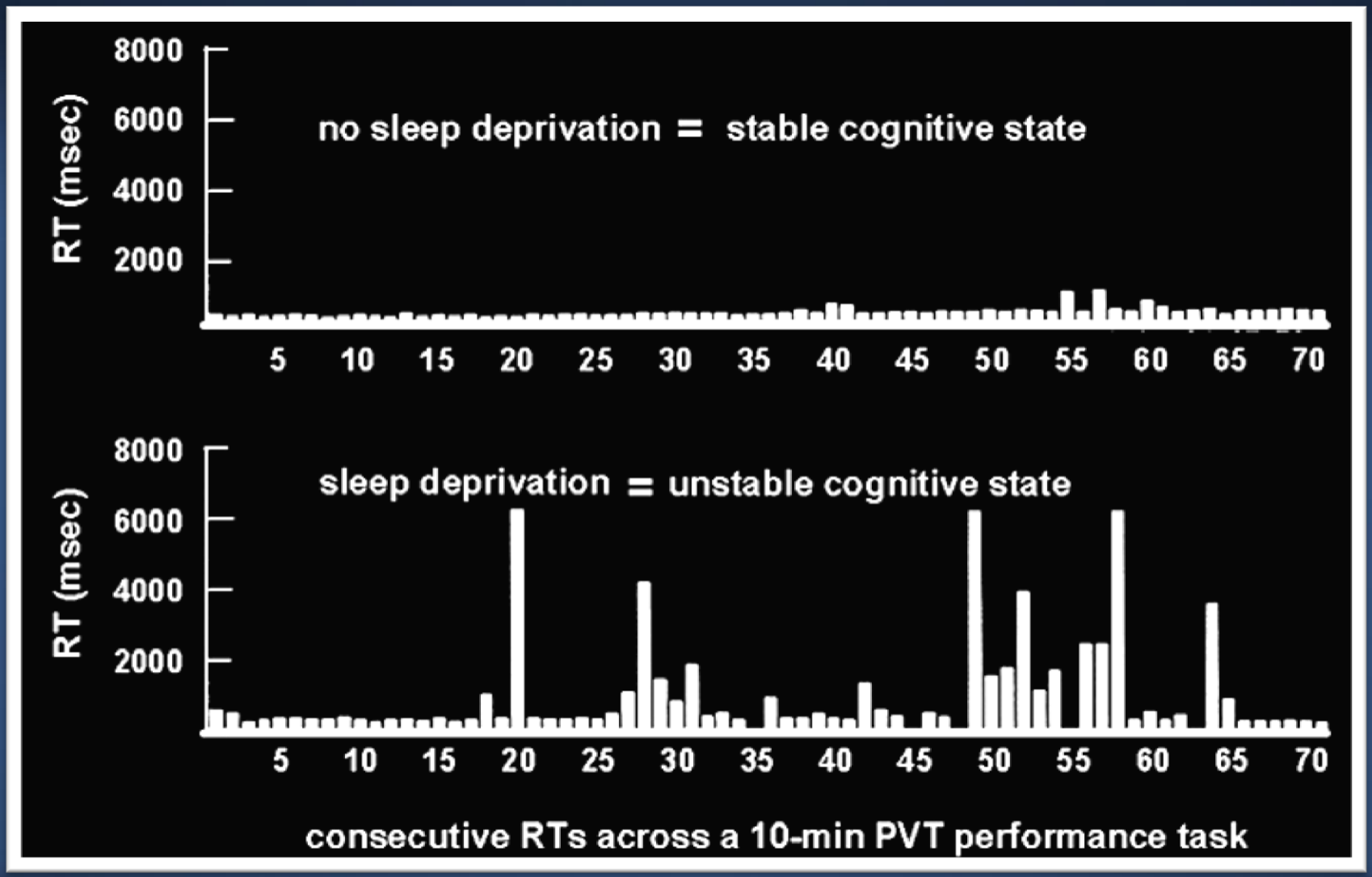
- degraded 20 – 50%+:

  - reaction time
  - memory
  - communication
  - situational awareness
  - judgment
  - attention
  - mood

- increased:

  - irritability
  - apathy
  - attentional lapses
  - microsleeps

Fatigue and Reaction Times



Doran SM, Van Dongen HP, Dinges DF. Sustained attention performance during sleep deprivation: evidence of state instability. *Archives of Italian Biology: Neuroscience* 2001;139:253-267.

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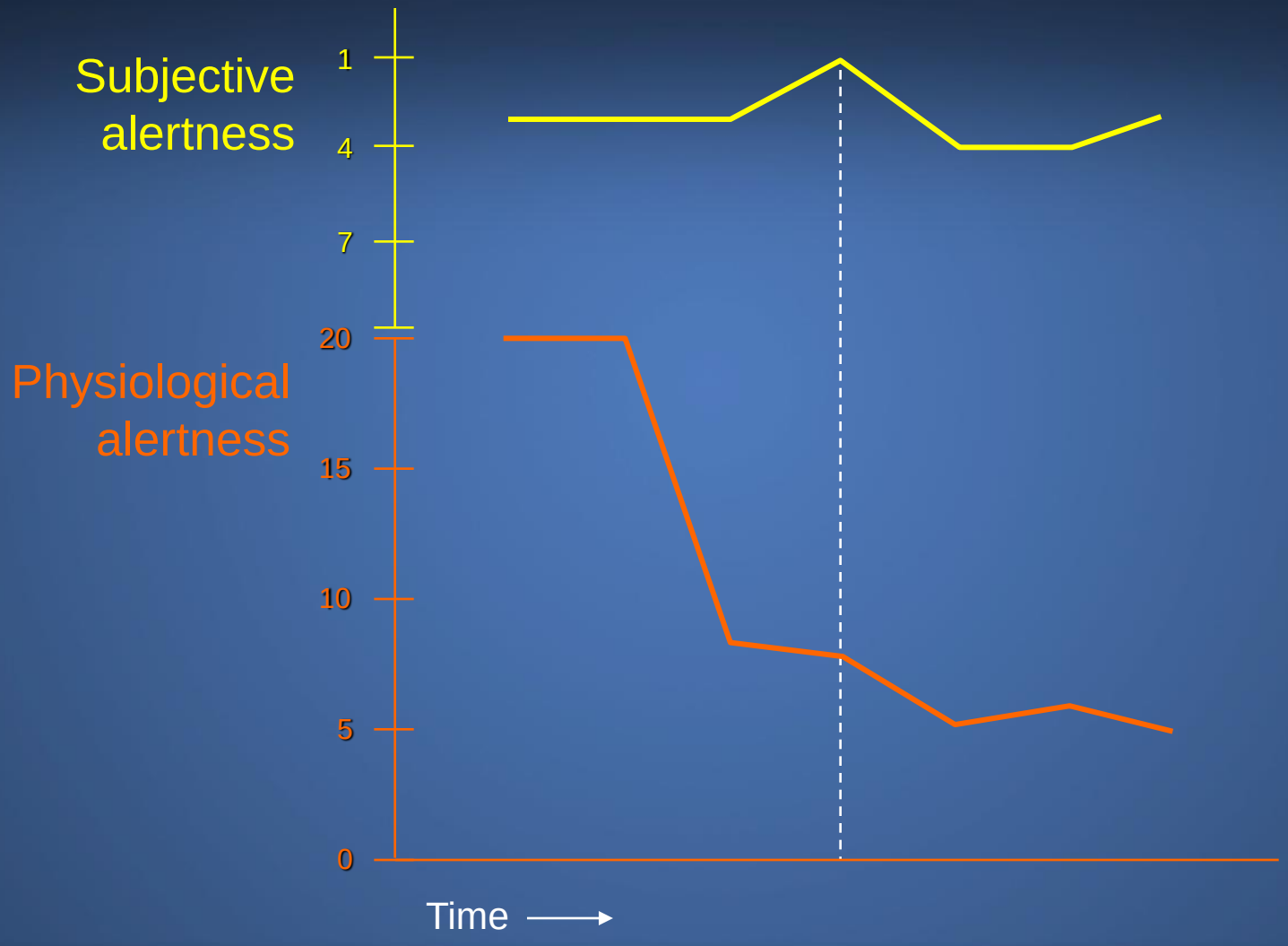
Alertness Reports Often Inaccurate



Adapted from Sasaki et al., 1986

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Examining Fatigue Factors in an Accident Investigation

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Four Fatigue Factors +

- Sleep loss
- Continuous hours of wakefulness
- Circadian/time of day
- Sleep disorders
- Other considerations

Fatigue Factors

- sleep loss
  - acute sleep loss
  - cumulative sleep debt
- hours awake
- circadian clock
- sleep disorders

Fatigue Factors

- sleep
- hours awake
  - > 12 hrs
  - > 16 hrs
  - 24 hrs
- circadian clock
- sleep disorders

Fatigue Factors

- sleep
- hours awake
- circadian clock
  - ‘sleepy’ windows
  - ‘alert’ windows
  - irregular schedule
  - time zones
- sleep disorders

Fatigue Factors

- sleep
- circadian clock
- hours awake
- sleep disorders
  - ~ 90 sleep disorders
  - sleep apnea

Sleep Apnea is a Safety Risk

- > 6 times increased risk for car crash
- SA performance = .06 - .08 BAC

Four Fatigue Factors +

- Other considerations (examples)
  - environment
  - task requirements
  - medical history/medications
  - alertness strategies

Four Fatigue Factors +

- Sleep loss
- Continuous hours of wakefulness
- Circadian/time of day
- Sleep disorders
- Other considerations

Fatigue Factors in Accident

- Identify if fatigue factors were present or not present at time of the accident
- Determine #/severity of fatigue factors
- Determine if fatigue factors present at the time of the accident affected performance changes that were contributory or causal to the accident

Accident Investigations

Go! Flight 1002

- early starts, multiple segment days, sleep apnea

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Honorable John K. Lauber:

No Accident ≠
Safe Operation

Uncontrolled In-Flight Collision with Terrain
AIA Flight 808, Douglas DC-8-61, N814CK
U.S. NAS, Guantanamo Bay, Cuba, August 18, 1993

First NTSB aviation accident investigation
to cite fatigue as probable cause

- acute sleep loss, sleep debt, circadian disruption

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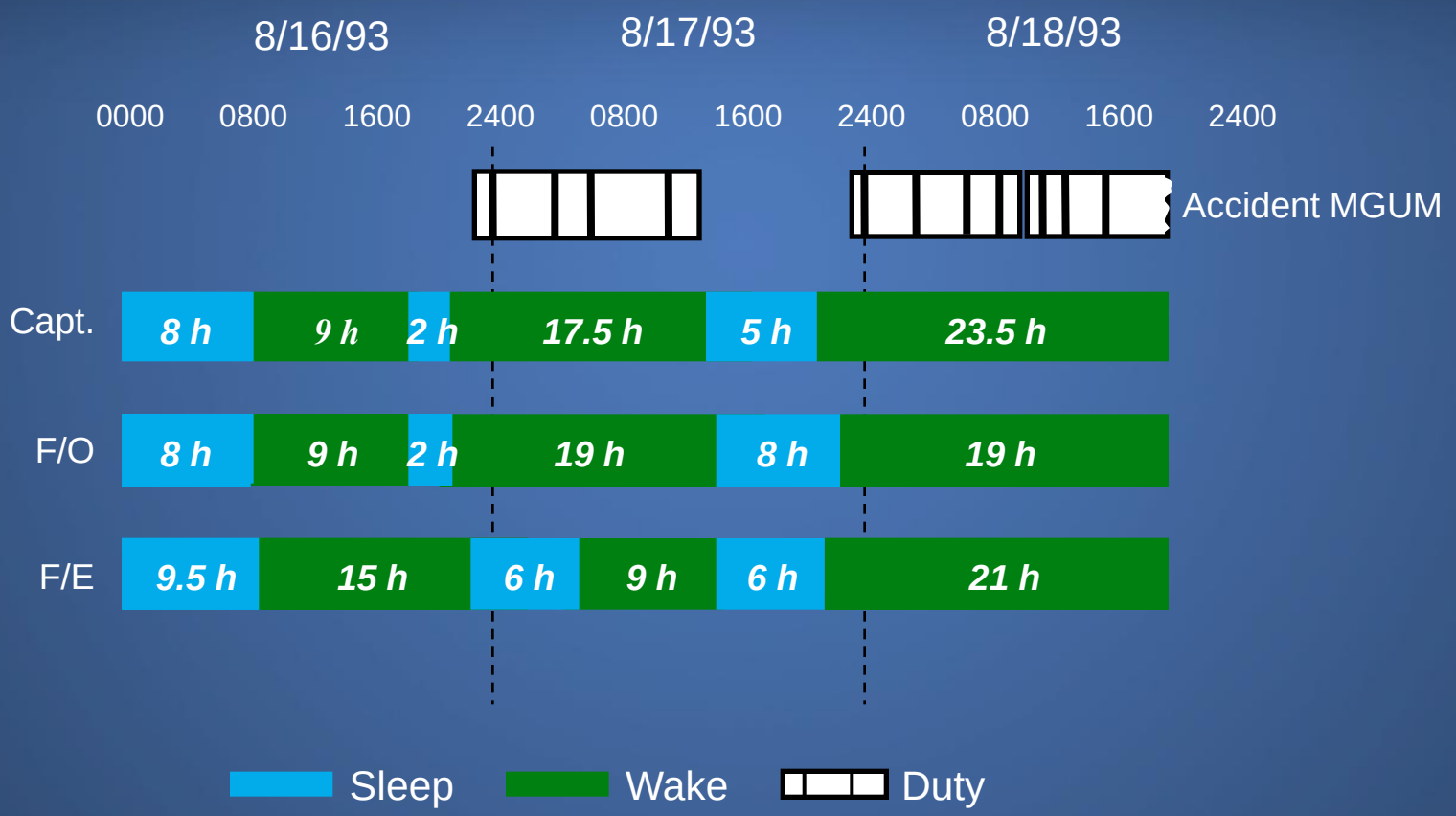
Crew Sleep History



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Observed Performance Effects

- Degraded decision-making
- Visual/cognitive fixation
- Poor communication/coordination
- Slowed reaction time

Uncontrolled In-Flight Collision with Terrain
AIA Flight 808, Douglas DC-8-61, N814CK
U.S. NAS, Guantanamo Bay, Cuba, August 18, 1993

"The National Transportation Safety Board determines that the probable causes of this accident were the impaired judgment, decision making, and flying abilities of the captain and flight crew due to the effects of fatigue…"

Owatonna, MN (July 31, 2008)

8 fatalities

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Owatonna Crew Fatigue Factors

- acute sleep loss (Capt/FO)
- cumulative sleep debt (FO)
- early start time (Capt/FO)
- excessive sleep need (Capt)
- insomnia (FO)
- self-medicate/prescription sleep med (FO)

Probable Cause/Contributing Factors

"Contributing to the accident were . . . (2) fatigue, which likely impaired both pilots' performance; . . ."

Lubbock, TX (January 27, 2009)

2 injuries

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Probable Cause/Contributing Factors

"Contributing to the accident were . . .

4) fatigue due to the time of day in which the accident occurred and a cumulative sleep debt, which likely impaired the captain's performance."

Miami, Oklahoma (June 26, 2009)
Fatigue Factors

- Off work for 3 weeks: day active/night sleep schedule
- 3am to 3pm shift work/drive schedule (since 1997)
- Early bedtime (2 hr phase advance in sleep time)
- Obtained min 3 hrs/max 5 hrs sleep prior to accident
- Subsequently diagnosed with mild sleep apnea

10 fatalities
3 serious injuries
2 minor injuries
5 no injuries

Source: Oklahoma State Police

Probable Cause (fatigue)

"... driver's fatigue, caused by the combined effects of acute sleep loss, circadian disruption associated with his shift work schedule, and mild sleep apnea, which resulted in the driver's failure to react to slowing and stopped traffic ahead by applying the brakes or performing any evasive maneuver to avoid colliding with the traffic queue. . . ."

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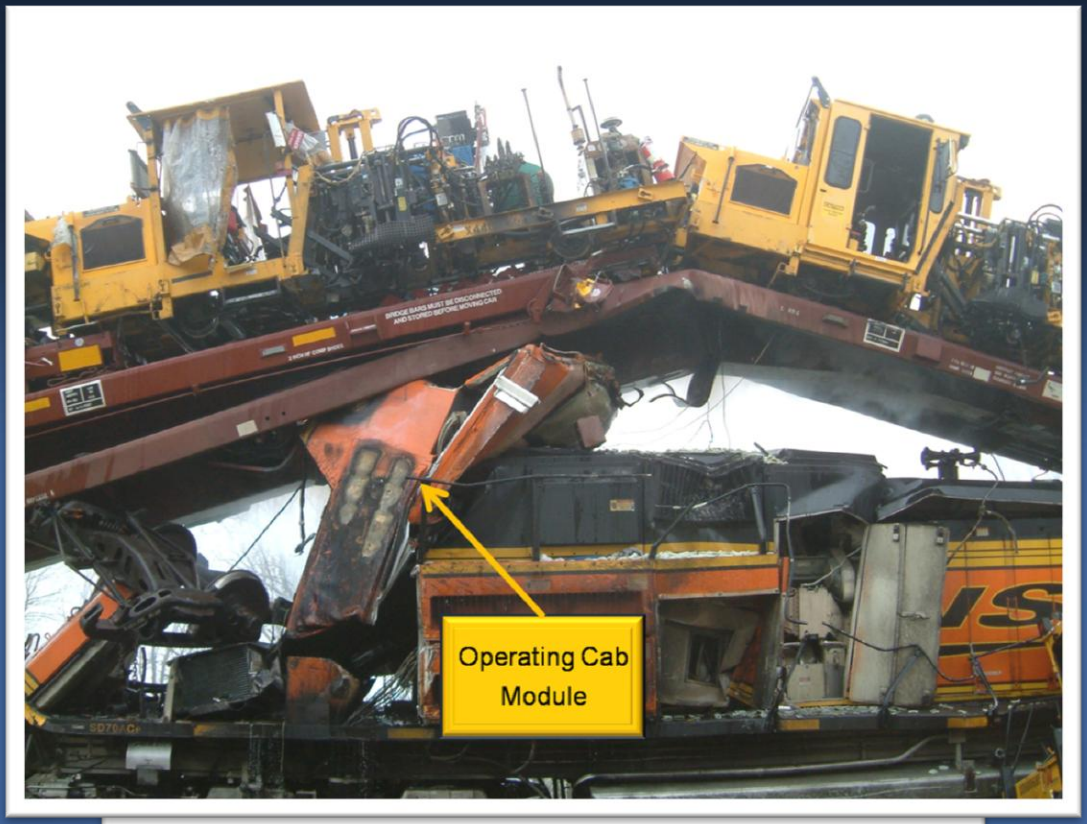
Track Path Animation

Collision Between Two BNSF Railway Freight Trains
Red Oak, Iowa
April 17, 2011
DCA11FR002



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Probable Cause (fatigue)

". . . failure of the crew of the striking train to comply with the signal indication requiring them to operate in accordance with restricted speed requirements and stop short of the standing train because they had fallen asleep due to fatigue resulting from their irregular work schedules and their medical conditions."

Collision of Tankship *Eagle Otome* with Cargo Vessel *Gull Arrow* and Subsequent Collision with the *Dixie Vengeance* Tow
Sabine-Neches Canal, Port Arthur, Texas
January 23, 2010

Accident Report

NTSB/MAR-11/04
PB2011-916404

National Transportation Safety Board

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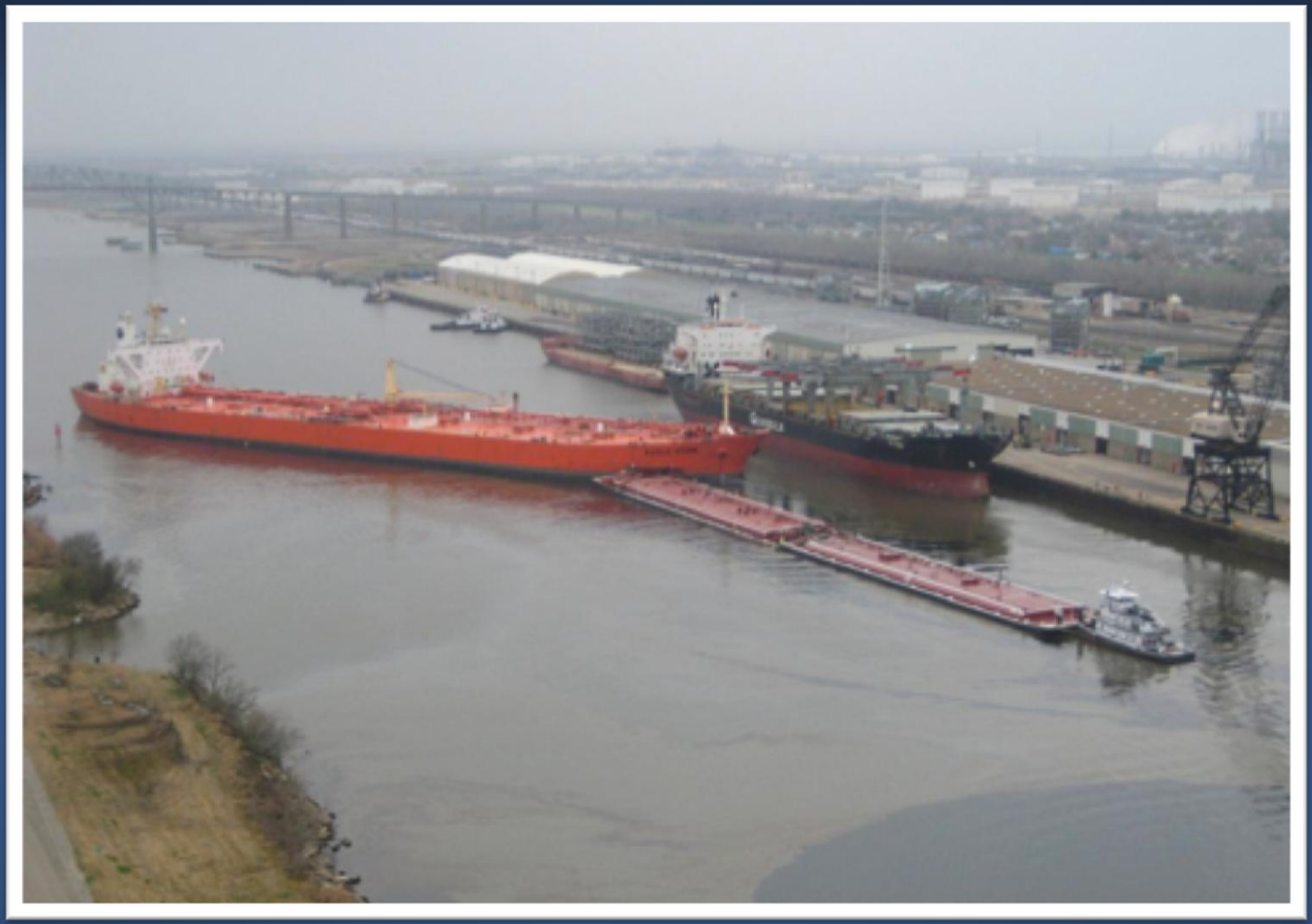
Eagle Otome, Port Arthur, TX



January 23, 2010

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Probable Cause/Contributing Factors

"Contributing to the accident was the first pilot's fatigue, caused by his untreated obstructive sleep apnea and his work schedule, which did not permit adequate sleep;"

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Animation of Accident Reconstruction

Motorcoach Run Off Road-Collision with Bridge Signpost

Interstate Highway 95 Southbound
New York, New York
March 12, 2011

HWY11MH005

‘Bronx Bus’, New York, NY (March 12, 2011)

15 fatalities

17 injuries

Probable Cause

"The National Transportation Safety Board determines that the probable cause of the accident was the motorcoach driver's failure to control the motorcoach due to fatigue resulting from failure to obtain adequate sleep, poor sleep quality, and the time of day at which the accident occurred."

GA Accident: GULF OF MEXICO (February 17, 1994)

THE PILOT FELL ASLEEP WHILE ENROUTE FROM SPRINGFIELD, KY TO CROSSVILLE, TN WHEN HE AWOKE 5 HOURS LATER HE FOUND THAT HE WAS OVER THE GULF OF MEXICO, 210 MILES SOUTH OF PANAMA CITY, FL, AND HAD ONLY 20 MINUTES OF FUEL REMAING. HE DECLARED MAYDAY ON 121.5 AND WAS ASSISTED BY COAST GUARD AND AIR FORCE AIRCRAFT. THEY DIRECTED HIM TO THE NEAREST AIRPORT, ST. PETERSBURG, FL WHILE ENROUTE TO THE AIRPORT THE ENGINES QUIT DUE TO FUEL EXHAUSTION AND THE AIRCRAFT WAS DITCHED, 70 MILES WEST OF ST. PETERSBURG. HE WAS RESCUED BY A COAST GUARD HELICOPTER.

GA Accident: GULF OF MEXICO (February 17, 1994)

- The National Transportation Safety Board determines the probable cause(s) of this accident to be:

  THE PILOT'S PHYSIOLOGICAL CONDITION (FAILURE TO REMAIN AWAKE) RESULTING IN EXTENDED FLIGHT OVER WATER FOLLOWED BY FUEL EXHAUSTION, TOTAL LOSS OF ENGINE POWER, AND DITCHING BEFORE RETURNING TO LAND.

Safety Recommendations

NTSB Safety Recommendations: Fatigue

- 40 years ago: May 10, 1972
- “Revise FAR 135 to provide adequate flight and duty time limitations.” (A-72-55)
- Classified “Closed-Unacceptable”

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Home > Transportation Safety > Most Wanted List

SHARE

MOST WANTED LIST

A program to increase the public's awareness of, and support for, action to adopt safety steps that can help prevent accidents and save lives.
The following are ten of the current issues.

Addressing Human Fatigue

General Aviation Safety

Safety Management Systems

Runway Safety

Bus Occupant Safety

Pilot & Air Traffic Controller Professionalism

Recorders

Teen Driver Safety

Addressing Alcohol-Impaired Driving

Motorcycle Safety

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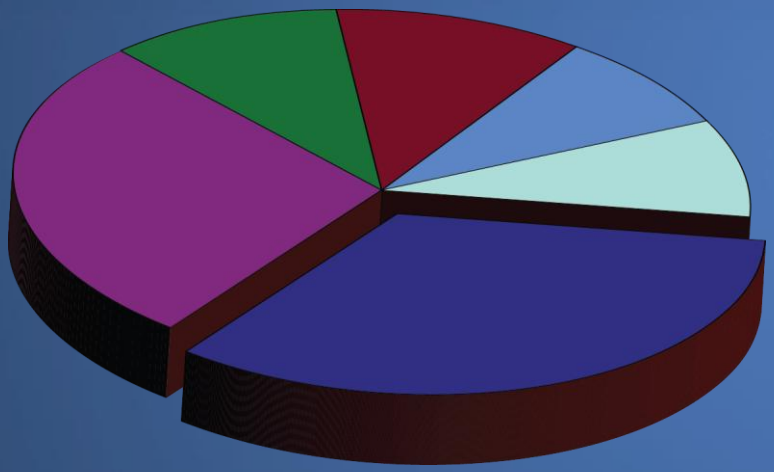
NTSB Recommendations

- MOST WANTED 1990 -2012
- ~200 fatigue recommendations

Complex Issue:



Requires Multiple Solutions

- Scheduling Policies and Practices
- Education/Awareness
- Organizational Strategies
- Healthy Sleep
- Vehicle and Environmental Strategies
- Research and Evaluation

NTSB Fatigue Recommendations: Education/Strategies

- Develop a fatigue education and countermeasures training program
- Educate operators and schedulers
- Include information on use of strategies: naps, caffeine, etc.
- Review and update materials

Scheduling Policies and Practices

- Day sleep, night drive, ~ 4 am WOCL

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NTSB Fatigue Recommendations: Hours of Service / Scheduling

- Science-based hours of service
- Allow for at least 8 hours of uninterrupted sleep
- Fatigue mitigation strategies in the hours-of-service regulations for passenger-carrying drivers who operate during the nighttime window of circadian low
- Reduce schedule irregularity and unpredictability

Sleep Apnea

- 360 rollover, 50/53 ejected, 9 fatalities, OSA (-CPAP)

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NTSB Fatigue Recommendations: Sleep Apnea/Health Related

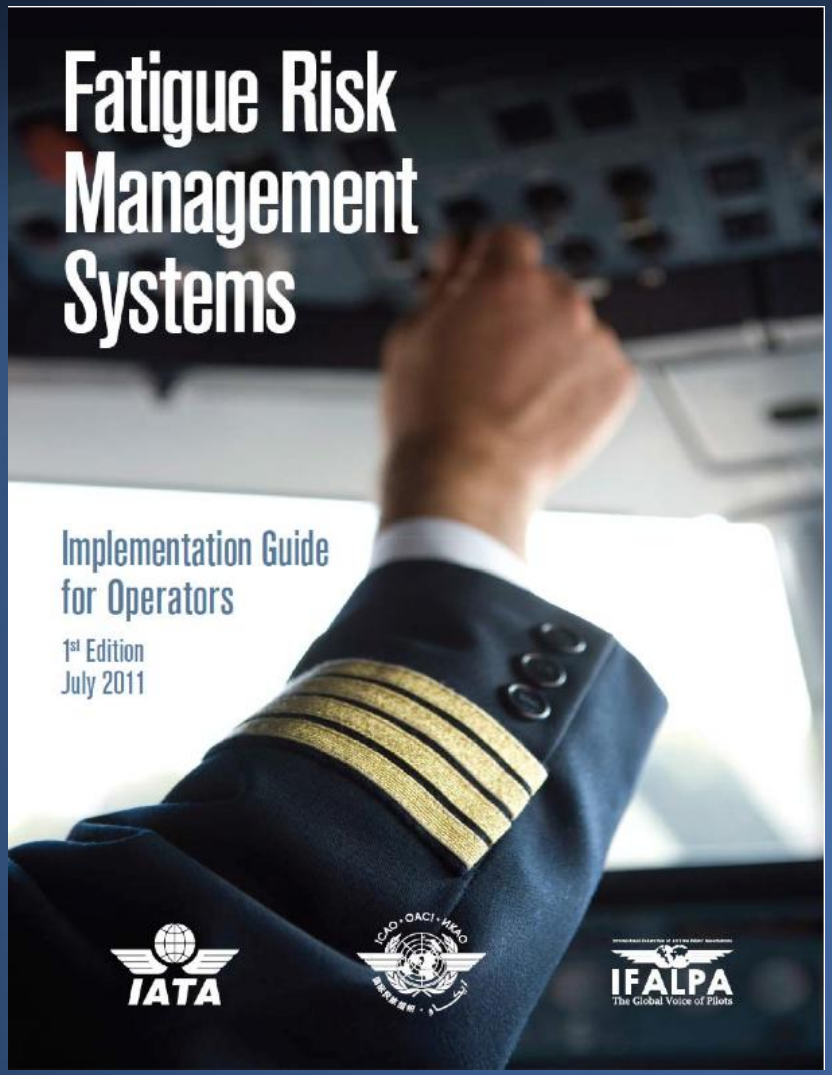
- Develop standard medical exam to screen for sleep disorders; require its use
- Educate companies and individuals about sleep disorder detection and treatment, and the sedating effects of certain drugs
- Ensure drivers with apnea are effectively treated before granting unrestricted medical certification

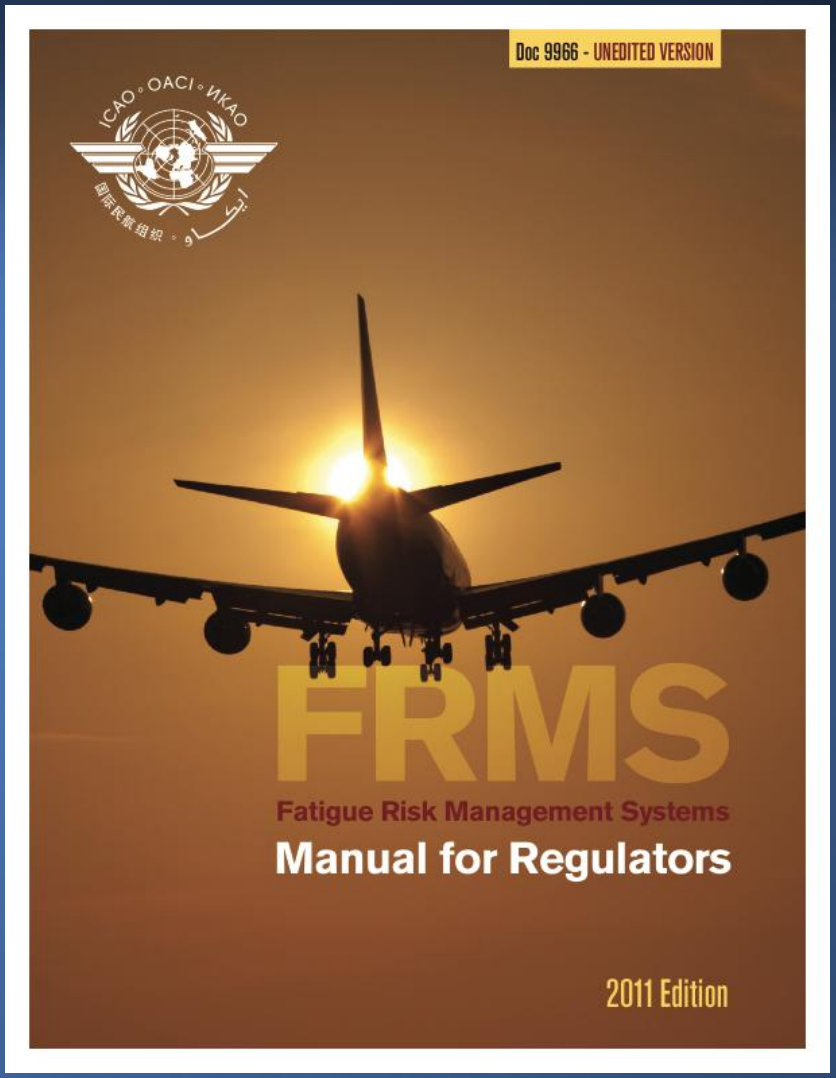
NTSB Fatigue Recommendations: Fatigue Management Systems

- Develop guidance based on empirical and scientific evidence for operators to establish fatigue management systems

- Establish an ongoing program to monitor, evaluate, report on, and continuously improve fatigue management programs implemented by motor carriers to identify, mitigate, and continuously reduce fatigue-related risks for drivers.

Examples


Fatigue Risk Management Systems
Implementation Guide for Operators
1st Edition
July 2011
IATA
ICAO • OACI • ИКАО
IFALPA
The Global Voice of Pilots


Doc 9966 - UNEDITED VERSION
ICAO • OACI • ИКАО
FRMS
Fatigue Risk Management Systems
Manual for Regulators
2011 Edition

NTSB Safety Recommendations: Fatigue Status (May, 2012)

- Total: 194
- Open: 48
- Closed: 146
- CUN*: 26

CUN = closed unacceptable

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Manage Fatigue = Enhance Safety

- Acknowledge risks
- Educate everyone
- Strong policies
- Take action/use strategies!
- Promote culture change

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